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CHILDREN'S READING--SYNTACTIC STRUCTURE AND COMPREHENSION DIFFICULTY. FINAL REPORT.

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THE CONCERN OF THIS STUDY WAS THE EFFECT OF SENTENCES OF VARYING STRUCTURAL COMPLEXITY ON PRIMARY GRADE CHILDREN'S ORAL READING, SILENT READING, AND LISTENING COMPREHENSION. THE AUTHOR PREPARED 36 ONE-SENTENCE "STORIES" WHICH VARIED IN STRUCTURAL COMPLEXITY AS ASSESSED BY THE DEPTH HYPOTHESIS OF STRUCTURAL DEPTH (YNGVE, 1960), SECTOR ANALYSIS OF STRUCTURAL DEPTH (ALLEN, 1964), AND TRADITIONAL STRUCTURAL ORGANIZATION. ONE-HALF OF THE SENTENCES REPRESENTED DIFFERENT DEGREES OF STRUCTURAL DEPTH, AND THE OTHER HALF, DIFFERENT TYPES OF STRUCTURAL ORGANIZATION. THE STRUCTURAL ORGANIZATION SENTENCES WERE RANKED AS COMPLEX, COMPOUND, AND SIMPLE AS DEFINED BY TRADITIONAL GRAMMAR. ALL SENTENCES WERE DESIGNED WITH THE SAME INTEREST AND DIFFICULTY LEVEL AND WERE APPROXIMATELY THE SAME LENGTH. THE SUBJECTS WERE 144 SECOND-GRADE CHILDREN, EITHER SCREENED BY A VOCABULARY TEST OR SELECTED WITHOUT THE TEST. THE SENTENCE "STORIES" WERE EXPERIMENTALLY ROTATED OVER THE THREE TASKS OF ORAL READING, SILENT READING, AND LISTING COMPREHENSION. COMPREHENSION OF EACH SENTENCE WAS MEASURED BY A PICTURE-COMPREHENSION TEST AND AN EVALUATION OF ORAL-READING SCORES. THE HYPOTHESIS THAT SENTENCES OF GREATER STRUCTURAL DEPTH WOULD BE MORE DIFFICULT FOR CHILDREN TO READ WAS PARTIALLY SUPPORTED BY THE ORAL-READING ERROR DATA, BUT NOT BY THE PICTURE-COMPREHENSION DATA. THE HYPOTHESIS THAT SENTENCES OF MORE COMPLEX STRUCTURAL ORGANIZATION WOULD BE MORE DIFFICULT TO READ WAS NOT SUPPORTED BY EITHER MEASURE. (JH)

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CHILDREN'S READING:

SYNTACTIC STRUCTURE AND COMPREHENSION DIFFICULTY

Children's acquisition and mastery of the reading process is the focus of primary grade education. The problem investigated in this study was one aspect of the relationship between syntactic structure and comprehension difficulty.

Grammatical Structure and Reading Comprehension

Reading comprehension has been shown to be influenced by syntactic structure in a variety of ways, including: the relationship of the sentence patterns in the reading passage to those in the children's oral language (Ruddell, 1963), sentence or independent clause length (Coleman, 1962), and the structural depth of the sentences in the reading passage (Bormuth, 1964a). The reader's awareness of grammatical structure (O'Donnell, 1963) and the emphasis on sentence patterns in the reading curriculum (Ruddell, 1966) have been shown to influence reading comprehension. These studies have been done with intermediate grade, high school, or college students. Little is known about the

relationship between syntactic structure and comprehension difficulty in primary grade children.

Readability studies usually find a significant relationship between some measure of sentence structure and reading comprehension. Once a vocabulary measure has been included in a readability formula, a measure of sentence structure adds relatively little to the formula's prediction of reading difficulty. In a study of fourth through eighth grade children's performance on a Cloze procedure test, Bormuth (1964b) found that mean word depth, computed according to Yngve's procedure, made a significant contribution to the prediction of the comprehension difficulty.

Measures of Structural Complexity

Yngve (1960) has proposed a model for language structure based on his work with computer translation. He defines the depth of a sentence in terms of a tree diagram of its constituent structure. A sentence is analyzed by successive binary divisions. Production of a left-hand branch of a sentence requires temporary storage in memory of the right-hand branch of the node. The structural depth of a sentence is the maximum number of such nodes that must be accumulated in the temporary memory at any point within the sentence. Comprehension involves understanding the grammatical complexity of the passage being read. Structural depth, which reflects the grammatical complexity of a sentence, may be a measure of the difficulty of comprehending that sentence.

An equally prominent procedure for measuring structural complexity is based on Allen's sector analysis (Allen, 1964). Allen has suggested that reading comprehension is dependent upon the reader's implicit analysis of the syntactic structure of a sentence. In his analysis of English grammar, Allen first identifies constructions that occupy certain defined positions within the sentence and then analyzes the positions within these constructions on lower levels. This process continues throughout the levels of a sentence until the word level is reached. The structural depth is the maximum number of levels required to go from sentence to word level. Allen has proposed that the sector analysis depth figure may be a measure of the readability of a passage.

The concern of this study was the effect of sentences of varying structural complexity on primary grade children's oral reading, silent reading, and listening comprehension.

Hypotheses

It was expected that sentences of more complex syntactic structure would be more difficult for primary grade children to read than would sentences of less complex syntactic structure when structural complexity was assessed by:

(1) structural depth, computed according to Yngve's depth hypothesis;

(2) structural depth, computed according to Allen's sector analysis; and

(3) structural organization, as defined by traditional grammar.

Materials, Procedures, and Sample

Thirty-six one-sentence "stories" were written, one-half representing varying structural depths and one-half representing three types of structural organization. The structural depth stories were written in six different forms and ranked into two high-, two mid-, and two low-depth sentences, according to Yngve's analysis. The same six sentences were also ranked into two high-, two mid-, and two low-depth sentences, according to Allen's analysis. The ranks given the sentences by the two analyses were not always the same, due to the different conceptions of structural depth in the two analyses. These differences allowed a comparison of the prediction of comprehension difficulty by the two depth analyses. The structural organization stories were written in three different types of organization, as defined by traditional grammar--complex, compound, and simple sentences.

The stories were the same interest and difficulty level, and the sentences were approximately the same length. The vocabulary used in the stories was words from the Dolch Basic Sight Vocabulary of 220 Words and the Dolch 95 Most Common Nouns, supplemented by words from the Ginn cumulative vocabulary for the first grade and the second grade, level one. Twelve of the stories (six structural depth and six structural organization) were read orally. The children read another 12 of the stories silently and had the remaining 12 read to them. The stories in their different forms were rotated over the three tasks. The children's comprehension of each story was tested by a picture comprehension test. Each child was shown three pictures

prepared for the story just read so that he could select the one which correctly depicted the events described in the story. The same pictures were used for each story regardless of the syntactic form in which it was read, and regardless of the mode of presentation. The children's reading was tape recorded, and an analysis of their oral reading errors was made as another measure of the comprehension difficulty of the sentences.

The subjects were second graders from a suburban Connecticut school system. They were tested in the spring and fall of 1966. One sample of 108 children, tested at the end of second grade, was selected on the basis of a vocabulary screening test. These children read orally a list of 20 vocabulary words selected at random from those used in the stories, and only children who could read at least 90% of them were used as subjects. When the sentences were administered to this selected group, the between-subjects variation was small, and the picture comprehension test was very easy. The reliability coefficients of these scores were severely limited when this screening procedure was used.

A second sample of 36 children, tested at the beginning of second grade, was selected without the vocabulary test. Any vocabulary words that the subjects did not know were supplied by the examiner for both the oral and silent reading tasks. Under these conditions the materials were of more appropriate difficulty for the children and the range of their scores on the picture comprehension test was wider. The split-half reliability coefficients for the total scores, calculated by applying the Spearman-Brown formula to the correlation between each

pair of scores, were .81 for the Yngve structural depth sentences, .77 for the Allen structural depth sentences, and .80 for the structural organization sentences. The reliability coefficients ranged from .43 to .72 for the separate oral and silent reading scores. The correlations of the total picture comprehension scores with the standard scores obtained on the Comprehension Test of the Gates-MacGinitie Reading Test, Primary B were .57 for the structural depth sentences and .61 for the structural organization sentences. These validity correlation coefficients ranged from .42 to .62 for the separate oral and silent reading scores.

The oral reading tapes for the sample of children screened on the vocabulary test were analyzed for oral reading errors by three experienced reading teachers. The errors tabulated were: corrections, substitutions, other errors (additions, omissions, repetitions), total oral errors (the first three categories combined), and hesitations. The percentage of agreement between at least two of the three judges ranged from 54% to 85%, and the correlations between the subjects' total oral errors and their standard scores on the Comprehension Test of the Gates-MacGinitie Reading Test, Primary B were -0.53 for the structural depth sentences and -0.40 for the structural organization sentences.

Results

The hypotheses that sentences of greater structural depth would be more difficult for primary grade children to read were partially supported by the oral reading error data, but not by the picture

comprehension data. The hypothesis that sentences of more complex structural organization would be more difficult for these children to read was not supported by either comprehension measure.

The scores obtained by the children on the picture comprehension test were analyzed by several three-way analyses of variance, testing the effects of syntactic structure, mode of presentation, and subjects. Because the stories were rotated completely over the subjects, a mixed model analysis of variance was used with subjects as the random effect. Table 1 gives the mean and standard deviation of the picture comprehension scores for the sample of children tested with the vocabulary screening test and for the sample of children tested without the vocabulary test. No significant differences due to structural complexity were found with the picture comprehension scores under either vocabulary condition. However, there were larger absolute differences between comprehensibility of varying levels of structural complexity with the vocabulary screening test than without.

Significant effects due to mode of presentation were found with the picture comprehension scores under the vocabulary screening conditions. Table 2 presents the confidence intervals for these comparisons among means, computed according to Scheffé's procedure (Hays, 1964). Silent reading comprehension was significantly more difficult than oral reading or listening comprehension. Listening comprehension was also easier than oral or silent reading comprehension when the subjects were not screened on vocabulary. It was not included in the analysis of variance under these conditions, however, because the distribution of scores was quite different from that of the reading comprehension scores.

Table 1

Mean and Standard Deviation[a] of the Picture Comprehension Scores

Type of Sentence	With Vocabulary Test[b]				Without Vocabulary Test[c]			
	Oral Reading	Silent Reading	Listening	All Modes	Oral Reading	Silent Reading	All Modes[d]	Listening
Yngve Structural Depth								
High	0.88 (0.33)	0.84 (0.37)	0.87 (0.34)	2.58 (0.62)	0.79 (0.41)	0.72 (0.45)	1.51 (0.60)	0.89 (0.32)
Mid	0.89 (0.31)	0.83 (0.38)	0.94 (0.23)	2.66 (0.60)	0.78 (0.42)	0.74 (0.44)	1.51 (0.67)	0.93 (0.26)
Low	0.91 (0.29)	0.88 (0.33)	0.85 (0.36)	2.63 (0.58)	0.76 (0.43)	0.79 (0.41)	1.56 (0.63)	0.93 (0.26)
All Depths	2.67 (0.56)	2.54 (0.67)	2.66 (0.70)	7.88 (1.12)	2.33 (0.89)	2.25 (0.90)	4.58 (1.40)	2.75 (0.47)
Allen Structural Depth								
High	0.87 (0.34)	0.85 (0.36)	0.91 (0.29)	2.63 (0.60)	0.79 (0.41)	0.69 (0.47)	1.49 (0.71)	0.93 (0.26)
Mid	0.92 (0.27)	0.85 (0.36)	0.89 (0.31)	2.66 (0.54)	0.76 (0.43)	0.75 (0.44)	1.49 (0.65)	0.92 (0.28)
Low	0.88 (0.33)	0.84 (0.37)	0.87 (0.34)	2.59 (0.62)	0.78 (0.42)	0.81 (0.40)	1.58 (0.60)	0.90 (0.30)
All Depths	2.67 (0.54)	2.54 (0.67)	2.66 (0.56)	7.88 (1.07)	2.33 (0.86)	2.25 (0.87)	4.58 (1.43)	2.75 (0.44)
Structural Organization								
Complex	0.83 (0.37)	0.87 (0.34)	0.93 (0.26)	2.63 (0.57)	0.86 (0.35)	0.72 (0.45)	1.58 (0.62)	0.92 (0.28)
Compound	0.88 (0.33)	0.92 (0.28)	0.90 (0.30)	2.69 (0.69)	0.81 (0.40)	0.74 (0.44)	1.54 (0.65)	0.90 (0.30)
Simple	0.90 (0.30)	0.87 (0.34)	0.86 (0.35)	2.63 (0.75)	0.79 (0.41)	0.78 (0.42)	1.57 (0.58)	0.90 (0.30)
All Types	2.62 (0.58)	2.65 (0.52)	2.68 (0.56)	7.94 (0.97)	2.46 (0.75)	2.24 (0.90)	4.69 (1.30)	2.72 (0.51)

[a] Standard deviations given in parentheses under each mean.

[b] Based on two observations per cell for each of 108 subjects. Maximum scores: Individual cells = 1, Rows = 3, Columns = 3, Total = 9.

[c] Based on two observations per cell for each of 36 subjects. Maximum scores: Individual cells = 1, Rows = 2, Columns = 3, Total = 6.

[d] Combined modes and total include oral and silent reading only.

Table 2

Confidence Intervals for Comparisons Among Means[a]--

Picture Comprehension Scores With Vocabulary Screening Test

Comparison	Confidence Interval Lower Limit	Upper Limit
Structural Depth--Mode of Presentation		
Listening - Silent Reading	0.05	0.19*
Listening - Oral Reading	-0.08	0.06
Oral Reading - Silent Reading	0.06	0.20*
Yngve Structural Depth & Mode of Presentation Interaction		
(Listening: Low - Mid) - (Silent Reading: Low - Mid)	-0.20	-0.08*
(Listening: Low - Mid) - (Oral Reading: Low - Mid)	-0.17	-0.05*
(Listening: Mid - High) - (Silent Reading: Mid - High)	0.02	0.14*
Structural Organization & Mode of Presentation Interaction		
(Listening: Simple - Complex) - (Oral Reading: Simple - Complex)	-0.21	-0.07*
(Listening: Compound - Complex) - (Oral Reading: Compound - Complex)	-0.15	-0.01*
(Listening: Compound - Complex) - (Silent Reading: Compound - Complex)	-0.15	-0.01*

[a] 95% confidence interval, computed according to Scheffé's procedure.

* An interval that does not contain zero implies a real difference.

There also was a significant interaction effect between levels of depth and modes of presentation under the vocabulary screening conditions. Confidence intervals for the comparisons among these means, computed according to Scheffé's procedure, are given in Table 2 also. For the Yngve depth analysis, oral and silent reading comprehension of sentences of low depth was easier than that of mid or high depth sentences, but listening comprehension of mid depth sentences was easier than that of high or low depth sentences. For the organization analysis, oral reading comprehension of complex sentences was more difficult than that of compound or simple sentences, and silent reading comprehension of complex sentences was more difficult than that of compound sentences. Listening comprehension of complex sentences, however, was easier than that of compound or simple sentences. Syntactic structure affected reading comprehension when the subjects had been screened on the vocabulary test, but the effects varied with the mode of presentation of the stories.

The oral reading tapes for the sample of children who had been screened on vocabulary were analyzed, using the five categories of oral reading errors. The mean and standard deviation of oral reading errors per sentence for each category of error are given in Table 3. They show that the subjects made very few errors per sentence, although there were wide differences among the subjects. These errors were analyzed by several two-way analyses of variance, testing the effects of syntactic structure and subjects.

Significant effects due to syntactic structure were found for hesitations in the Yngve and Allen structural depth sentences and in

Table 3

Mean and Standard Deviation[a] of Oral Reading Errors by Sentence[b]

Type of Sentence	Corrections	Substitutions	Other Errors	Total Errors	Hesitations
Yngve Structural Depth					
High	0.24 (0.25)	0.19 (0.32)	0.28 (0.31)	0.71 (1.16)	0.64 (0.77)
Mid	0.18 (0.20)	0.19 (0.28)	0.24 (0.24)	0.61 (0.77)	0.51 (0.55)
Low	0.18 (0.22)	0.22 (0.28)	0.21 (0.19)	0.61 (0.78)	0.36 (0.41)
Allen Structural Depth					
High	0.28 (0.30)	0.19 (0.27)	0.29 (0.34)	0.76 (1.18)	0.68 (0.71)
Mid	0.16 (0.17)	0.22 (0.33)	0.21 (0.21)	0.59 (0.80)	0.45 (0.59)
Low	0.16 (0.19)	0.20 (0.28)	0.23 (0.19)	0.59 (0.73)	0.38 (0.43)
Structural Organization					
Complex	0.16 (0.17)	0.15 (0.22)	0.15 (0.17)	0.46 (0.62)	0.36 (0.41)
Compound	0.15 (0.17)	0.07 (0.08)	0.20 (0.20)	0.41 (0.46)	0.39 (0.46)
Simple	0.16 (0.19)	0.19 (0.24)	0.16 (0.15)	0.51 (0.70)	0.25 (0.29)

[a] Standard deviation given in parentheses below each mean.

[b] Based on two observations per level of structural complexity for each of 108 subjects.

the structural organization sentences, for corrections and for total oral errors in the Allen depth sentences, and for substitutions in the structural organization sentences. Confidence intervals were constructed, using Dunn's procedure (Dunn, 1961), for the comparisons among means. The upper and lower limits of these intervals are given in Table 4.

Sentences of high Allen depth produced significantly more corrections and hesitations than did those of mid or low depth. Sentences of high Yngve depth also produced significantly more hesitations than did those of low depth. Simple sentences resulted in significantly more substitutions than did compound sentences.

Several additional analyses of oral reading errors were made. The oral reading repetitions were tabulated as a repetition of either a whole structural unit or a part of a structural unit. When a child repeated a whole unit, it was assumed that he understood the relationship of that unit to the rest of the sentence. The proportion of whole-unit repetitions decreased with increasing sentence complexity.

When uncorrected substitutions, additions, and omissions occurred, the resulting sentence might or might not be a complete, meaningful sentence--semantically and grammatically. These errors more frequently "made sense" in the sentences of low structural depth and simple structural organization than they did in the more complex sentences.

The hesitations were analyzed as occurring at grammatical or non-grammatical junctures according to the criteria established by

Table 4

Confidence Intervals for Comparisons Among Means--Oral Reading Errors[a]

Comparison	Confidence Interval Lower Limit	Upper Limit
Yngve Structural Depth		
Hesitations		
Mid - Low	-0.02	0.32
High - Low	0.11	0.45*
High - Mid	-0.04	0.30
Allen Structural Depth		
Corrections		
Mid - Low	-0.11	0.11
High - Low	0.01	0.23*
High - Mid	0.01	0.23*
Total Oral Errors		
Mid - Low	-0.01	0.35
High - Low	-0.01	0.35
High - Mid	-0.18	0.18
Hesitations		
Mid - Low	0.07	0.39*
High - Low	0.14	0.46*
High - Mid	-0.09	0.23
Structural Organization		
Substitutions		
Compound - Simple	-0.22	-0.02*
Complex - Simple	-0.14	0.06
Complex - Compound	-0.02	0.18
Hesitations		
Compound - Simple	0.00	0.28
Complex - Simple	-0.03	0.25
Complex - Compound	-0.11	0.17

[a] 95% confidence interval, computed according to Dunn's procedure.

* An interval that does not contain zero implies a real difference.

Henderson, Goldman-Eisler, and Skarbek (1965). Fewer hesitations occurred at nongrammatical junctures in the sentences of less complex syntactic structure than in those of more complex structure.

Evidence from the analysis of oral reading errors shows that sentences of more complex syntactic structure, according to the Yngve and Allen measures of structural depth and according to the traditional grammar definition of structural organization, are more difficult for primary grade children to read and understand.

Discussion

Vocabulary is a major factor in comprehension difficulty at any level of reading. Its role is especially large in beginning reading where comprehension of materials depends heavily on word knowledge and word attack skills. For this reason, vocabulary was controlled in the initial phases of this study. However, when both the vocabulary range of the materials and the vocabulary knowledge of the subjects were controlled, major sources of variability in comprehension difficulty at this level were removed, and the range of the picture comprehension scores was restricted. When the subjects were not screened on vocabulary, however, there was more variability in their vocabulary knowledge, and the distribution of comprehension scores was wider. The sentences were more difficult for these subjects, in spite of the fact that the vocabulary words which they did not know were supplied during oral and silent reading. However, there were smaller absolute differences between levels of syntactic structure under these conditions than when the subjects were screened on vocabulary.

Additional investigation of the effects of syntactic structure on primary children's comprehension needs to be undertaken using longer passages and other comprehension measures. A significant interaction effect was found in this study between levels of structural complexity and modes of presentation. Within the oral and silent reading modes, complex structures were more difficult to understand, but within the listening mode the simpler structures were more difficult. This interaction finding also needs to be investigated further. This study was initiated, in part, to learn what types of syntactic structure should be used in beginning reading materials. The results indicate that strict control of sentence structure in primary grade materials is probably not necessary. However, these results should not be interpreted to mean that any sentence structures, no matter how complex or long, should be used in these materials. Primary grade reading materials need to continue to give major attention to vocabulary control and development, but the analysis of oral reading errors suggests that sentences must not be unduly long or complex. As more complex syntactic structures are introduced into primary grade reading materials, instruction should be given in ways of handling the increasing complexity of sentences.

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